CIE **Review of Alaska Rockfish Assessments**, 9-11 April 2013, Alaskan Fisheries Science Center, Juneau, Alaska

Sven Kupschus

Prepared for

Center for Independent Experts (CIE)

Centre for Environment, Fisheries and Aquaculture Science
Lowestoft Laboratory
Pakefield Road
Lowestoft
Suffolk NR33 0HT
United Kingdom

Telephone: +44 1502 524454
e-mail: sven.kupschus@cefas.co.uk
www.cefas.co.uk

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The meeting was open to the public but was not attended by stakeholders. Much of the time at the meeting consisted of presentations given generally in line with the terms of reference and across stocks which provided a nice overview regarding the commonalities and differences in the assessment approaches. However, this made the evaluation of the individual assessments more difficult leaving insufficient time during the review to fully evaluate the specifics for all of the assessments. In general, the questions asked of the reviewers in relation to the advice were relatively general with respect to the approaches to assessments and management including spatial allocation rather than the verification of the specific ABC's. Assessment reports were well presented and, together with the presentations, formed a sound basis for the management, but were often insufficiently detailed in terms of the diagnostics to assess the suitability of the assessment underlying the advice. A more detailed presentation of some data summaries/analysis would have been desirable, as would a more detailed presentation of individual model diagnostics, including a detailed split of the likelihood components for comparison between different model settings. These were provided up on request during the meeting, but there was insufficient time to investigate the assessment model responses to different settings / assumptions to ascertain which options presented the most promising approaches for improving the assessments.

The review was conducted in the Alaska Science Center, in Juneau, Alaska.

The review panel was provided with a large quantity of biological and background material on data sources relevant to the evaluation of rockfish stocks in the Gulf of Alaska, Bering Sea and Aleutian Islands. The age-based assessments did not, however, provide sufficient diagnostics for the reviewers to be able to evaluate fully the appropriate use of this information in the implementation of the models. At the review meeting there was only sufficient time to examine and discuss the detail of such implementations for the BSAI Pacific ocean perch stock, so the details discussed in this review are examples of assessment improvements rather than an exhaustive diagnostic evaluation of the suite of age-based assessments.

The assessment approach for tier 3 stocks is based on proven methodology and the data sources are sufficiently sound to underpin management. It appears that improvements to model implementation are possible, or should at least be investigated, but the results thus far appear to be sufficiently robust under current exploitation levels to be used for management advice. Considerations of selectivity models and weightings for the likelihood contributions of different data sources may offer ways to improve models.

Tier 5 assessments are currently largely based on survey abundance information, and for a number of stocks, this information is highly variable, making management advice unpredictable and difficult to deal with for fishermen. The problem is exacerbated by the fact that many of the stocks represent bycatch species that can potentially affect the harvest of target species. In addition, the issue of survey catchability discussed at length in the previous review of the rockfish stocks has not yet been addressed sufficiently adequately to provide more accurate estimates of abundance.

For stocks with high variability, rather than a concern over bias, a state-space random walk model promised some improvement to the situation both in terms of reducing the variability in management recommendations and in improving the determination of uncertainty in the estimates. Work to test and implement this method for future management should be supported.

Both the tier 3 and tier 4/5 management approaches are sufficiently conservative in general to have recovered and sustained stocks at appropriate levels up to this point, and they appear to be sustainable for fully mixed stocks.

Genetic information on the stock structure of rockfish indicates that generational migration rates are in the order of hundreds of kilometres, which given the very large stock areas, give rise to concerns over localised overexploitation which potentially could lower the overall stock productivity, suggesting that the stocks are significantly more vulnerable than a fully mixed population if exploited unevenly. Although uneven distribution of fishing effort is likely to reduce stock productivity, it is very unlikely to lower genetic diversity sufficiently to be of great concern because the fishery would likely become economically unviable long before genetic diversity became a serious issue.

Current management is based on a fairly precautionary approach to exploitation. With some improvements to assessments and better understanding of the spatial distribution of populations and fishing effort, higher long-term yields may be obtainable from a number of stocks, but the increased complexity of management and additional data requirements may not prove to be economically sensible. The conservative approach to management assuming a mixed stock almost certainly has contributed to the maintenance of the rockfish resources at their current levels despite their greater than anticipated vulnerability to exploitation as a consequence of limited mixing within the stock.

Spatial allocation of ABCs or TACs is generally appropriate for tier 3 stocks, but spatial management regions are generally larger than the assumed average generational migration distance. For tier 5 stocks, there is concern that methods for spatial allocation and setting stock-wide ABCs are inconsistent with the results from the assessments. In some cases, the ABC may be based on the biomass estimate over the last 3 surveys, although allocation to area may be based on the composition in the final year only. Such inconsistencies could lead to regional overexploitation, although they currently appear not to have done so. Apportioning regional quotas should be consistent with the methodology used for setting ABCs in the first place.

The random walk state-space model may represent an alternative, more robust and less variable approach to setting catch levels for tier 5 stocks than is currently possible using survey information, notwithstanding the current concerns over biased (because of the assumption that $q = 1$) survey estimates for species that are either strongly associated with trawlable or untrawlable habitat.

BACKGROUND

In accordance with the Statement of Work (SOW: Appendix 2), I was contracted to participate as a CIE independent review panellist for the 2013 CIE Review for selected Alaska rockfish. This document represents my own findings and interpretation of the information provided, and is based on the panel meeting and discussions. However, some of the thoughts and conclusions were formulated in the process of writing this report, so may not have been discussed in specific detail at the review. Unlike some assessment review panels, the focus of the group convened for this task was more on the suitability of the assessments, possible further improvements to assessments, and the most suitable basis of advice, rather than specific recommendation of exploitation levels/OFLs for the coming year.

REVIEW ACTIVITIES

The 2013 rockfish review was held at the Alaska Fisheries Science Center (AFSC) in Juneau, Alaska, from 9th to 11th April 2013. The bibliography consulted is listed in Appendix, and the Terms of Reference for the CIE panel in the scope of work Appendix 2: Annex 2.

A list of participants including panel members, SSC representation and observers are listed in Appendix 3. The meeting was open to the public but was not attended by stakeholders. Much of the time at the meeting consisted of presentations given generally in line with the terms of reference and across stocks which provided a nice overview regarding the commonalities and differences in the assessment approaches, however made the evaluation of the individual assessments more difficult leaving insufficient time during the review to fully evaluate the specifics for all of the assessments. In general, the questions asked of the reviewers in relation to the advice were relatively general with respect to the approaches to assessments and management including spatial allocation rather than the verification of the specific ABC's. Assessment reports were well presented and, together with the presentations, formed a sound basis for the management, but were often insufficiently detailed in terms of the diagnostics to assess the suitability of the assessment underlying the advice.

FINDINGS BY TERMS OF REFFERENCE

a. Evaluation of data used in the assessments, specifically trawl and longline survey abundance estimates, and recommendations for processing data before use as assessment inputs.

Catch data

Information on current catch and fish length and age is good for most rockfish species, although for some species there remain issues with identification, especially in the species complexes. Observer coverage for some of fleets is at or close to 100% (boats participating in the rockfish management plan), with the larger processor boats being covered at ~35%. Smaller coastal boats representing a much smaller portion of the total catch for most species tend to have less coverage. Recent problems with non-random sampling, with some fishers deciding on the trips for which they would take samplers on board, are or will be eliminated with the more random draw system now in operation. Consequently, recent catch histories can are precisely estimated be seen as being highly are highly certain despite high discard rates of up to 50% for some species of rockfish. In contrast, the historical catch data, especially during the period of foreign fleet exploitation in the 1960s are determined more poorly. Although significant effort has gone into determining the landings of that fleet, data reporting was poor in terms of catch composition. The main target of the fishery then was Pacific ocean perch, which almost certainly constituted most of the catch. However, other species were caught, and for those species, catches are estimated to have been taken in constant proportion across time. As a consequence, the catch history of all of rockfish species in this fishery shows a sharp spike in the mid 60's during the peak of foreign fleet landings, followed by a steep decline as foreign boats were replaced by venture fisheries following the extension of the national EEZ. Historical information on the magnitude of total catches during that period is estimated as best as possible, but in my opinion still contains more uncertainty than the current catches for Pacific ocean perch. There is significant additional uncertainty in the catches of other species given the uncertainty of the catch proportion information and the relatively small proportion of other species estimated to have been caught. Better ways of dealing with this uncertainty need to be sought in the assessment, or at least examined by sensitivity analyses (see assessment section). Faunce (2011) suggests that more recent species identification by processors still produces errors in the quota debiting beyond the species dealt with in complexes. Therefore, it is not clear whether the high constraint on catch data is even appropriate for the current catch data.

Trawl survey

Both the Gulf of Alaska (GOA) and Bering Sea and Aleutian Islands (BSAI) trawl surveys conducted by the National Marine Fisheries Service (NMFS) follow stratified random designs, although the extent of randomness differs. The BSAI survey is confined to a random selection of some 400 tows from around 1000 stations assessed as trawlable, and the proportion in some strata is even higher, approaching in some cases a fixed station design. The proportion of actual stations in relation to possible stations is much smaller in the GOA, resulting in greater randomness of samples and consequently a lower possibility of bias.

Mean abundance estimates by strata are determined and multiplied by stratum area (including untrawlable ground) to estimate population abundance. It is of note that the grounds deemed untrawlable for the survey are not necessarily considered untrawlable for the fishery, which frequently uses rock hopper gear to exploit such areas. Application of catches to the total area within a stratum then assumes an even distribution of fish across the area despite differences in habitats. The evidence for rockfish habitat association suggests that the area-wide biomass estimates from both surveys are inappropriate on an absolute scale, but generally appropriate for use in the tier 3 rockfish assessments where they are used to determine population abundance trends. Temporal or ontogenetic shifts in habitat could still produce biases in biomass even if considering relative trends only. Currently though, available information provides no evidence of temporal changes although generally it is too limited even to make reasonably accurate estimates of the mean proportion within a habitat.

For tier 5 assessments, using estimates of survey biomass as absolute values is potentially more problematic. This was discussed in detail at the previous CIE review of the stocks, and the concerns highlighted and possible options for correction given are still applicable. Therefore, they are not discussed further here, except in terms of the new comments below.

Under resource limitation, stocks may spill into marginal habitats for a species with the consequence of introducing hyperstability into biomass trends of the species associated with trawlable habitat. In that case, the greater concern would be for species associated with untrawlable habitat, where such expansion would produce hypervolatile indices and result in inappropriate management advice for tier 5 species whose TAC is set on the basis of a disproportional increase in abundance estimates and for which catches are taken in areas not surveyed.

Recent camera / ROV work conducted during surveys has shown that for many species, the densities of rockfish on trawlable and untrawlable ground differs significantly from the ratio of trawlable to untrawlable areas, suggesting that absolute biomass estimates will be significantly biased for many species. The latter issue is particularly problematic for tier 5 rockfish assessments because there is no mechanism to scale the estimates up to absolute biomass.

Longline survey

The longline survey carried out under cost recovery measures by the industry (i.e. paid for by the fishery) is conducted over a narrower, but deeper depth range throughout the GOA and the eastern Aleutian Islands. In addition to extending the depth range sampled, it is much less constrained by habitat relief than the trawl survey. As such, it offers the possibility of examining a wider range of species. This would be very useful particularly for those tier 5 species thought to have affinity for untrawlable ground. However, the information can be used only in a relative sense for three reasons: the effective sampling area is not estimable, stations are fixed so as not to be necessarily representative of the whole area, and the area covered by the survey does not include the full extent of the species distribution, only partially overlapping with coverage of the trawl survey. In addition hook saturation appears to be a potentially serious problem when taking into account other species caught in large numbers, such as sablefish. Estimates of rockfish population trends for species that spatially overlap less with other abundant species caught or that are aggressive predators are less likely to be affected by hook competition and therefore the estimates made. Such estimates may represent an important additional source of information for tier 3 assessments in the GOA. For the BSAI area, the case is less clear because the survey only partially covers the whole area, and if there are area differences between the western and eastern Aleutian populations the survey would not be representative of the stocks.

Survey precision

Precision estimates from the survey based on the stratified variance estimate are generally low, and there was a request to consider ways of improving the utility of the survey for the assessments. Possible ways to proceed depend on contagion in the error distribution.

For many of the species, catch frequency distributions are clumped, i.e. catches are either large or absent, with few intermediate values. Often, these are species that are thought to be more closely associated with untrawlable ground and for which catches are merely coincidental, as indicated by their more spatially scattered catch distribution. It seems, though, that it would be possible to apply some form of post-stratification or habitat correction for some species; my experience is that if the main portion of the biomass is outside the sampled zone, it is difficult to draw inference on population trends on the basis of the marginal population in the area sampled. Models can still be applied and tend to produce favourable results in terms of statistical property, but they generally overestimate the precision of the estimate, because they incorrectly interpret sampling variability as trend. The problem is that there are many samples (and hence many degrees of freedom), but the information content is so low that the model is effectively over parameterised. I consider that little can be done to improve the precision estimates for species that have only a small, highly variable proportion of the population in the trawlable habitat.

Assessments for the species that tend to be found in untrawlable habitat to a lesser degree and show a more spatially persistent pattern of distribution in the trawlable areas can be improved. Such an approach is essentially one of post-stratification using generalized models that account for the variability in habitats sampled by adjusting the abundance estimate. Generally, these solutions will solve only the precision issue, not the issue of bias caused by inaccessible areas. However, in some cases, the model can be used to apply the information to areas not sampled if the habitat conditions in those areas are known and the reasons for not sampling those areas are independent of the distribution of the species. Regrettably, however, the latter requirement generally does not seem to apply to rockfish.

For rockfish generally, there is a more or less continuously declining frequency distribution with zero the most common value, and some high abundance incidences. The excess of zero values in the data in the literature is often seen as a justification for using zero-inflated models (delta-gamma, delta-lognormal), applying one model to assess the probability of presence absence, then independently assessing the likely abundance assuming the presence of the species in question. Although that approach is technically possible given the availability of such data, it is statistically inappropriate for schooling species. The approach is aimed at removing the autocorrelation that the presence of one individual has on the likely presence of others. When the true underlying cause of the aggregation is unknown or is mainly associated with environmental conditions rather than schooling behaviour, the results are at best uninterpretable ecologically or at worst altogether misleading.

The problem is that the exclusion of all zero values from the positive submodel assumes that all such values are linked to presence/absence. For schooling species this is largely true, but for less aggregated, less abundant species, a zero value can mean merely that the sample did not contain the species despite its general presence in an area (i.e. the zero is reflective more of sampling variability). The second submodel is therefore an overestimate of abundance compensated for by an underestimate in the first submodel, and often implies that a species schools at one end of the environmental gradient while acting territorially at the other end of the same gradient, a situation that is not very realistic behaviourally.

Rather than true schooling, i.e. when the mere presence of an individual implies the presence of others, rockfish are thought to aggregate under favourable environmental conditions for most of the year. In such a case, rather than the zero-inflated approach, a Poisson assumption for the error distribution would be more appropriate. Assuming the variables important in describing the spatial distribution are known / recorded, zero catches will then be correctly attributed to unfavourable environmental conditions and to sampling variability at low abundance. Although only relatively few environmental conditions are known to drive distribution trends, meaning that aggregation would appear to be behaviourally quasi-likelihood-based rather than Poisson-based, models can be developed to deal appropriately with the situation and there is no need to move to zero-inflated models unless the frequency distribution is clearly multimodal rather than contiguous.

Generalized additive models offer the most flexibility in such cases, with their inherent ability to explore the complex ecological relationships that monotonic functions are unable to ascertain. However, they do suffer significantly when information content is low, especially at the extremes of environmental gradients where data are sparse and splines have difficulty operating. In such cases, the AIC (based on the ratio of parameters to samples rather than information content) often specifies much greater levels of function complexity than are warranted from either a theoretical or an ecological perspective. In such cases, other ways of evaluating model parsimony need to be sought or less-demanding methods such as GLMs should be applied.

In my experience where reasonable environmental information is available models can reduce variance estimates by around 20–30% for a relatively small number of model degrees of freedom. Further improvements usually take considerably greater increases in terms of model parameters and in my opinion are difficult to justify. A downside of this approach is that historical estimates of survey abundance will continue to change as new data become available. The additional data may well define the relationship between abundance and the environment better, and when the new information is applied to historical data this can result in changes in past biomass estimates. Usually such changes are small if model complexity is appropriately specified, but they can still be undesirable if, for example, a historical estimate of stock status is changed from one year to the next. Furthermore, if the mixing in rockfish is more restrictive than the distances between habitats (see TOR d), the approach may not work well because it does not represent an ideal free distribution. The abundance at a location may be more representative of the availability of fish able to move into an area (or the number of fish having been removed) rather than the quality of the habitat available. In that case, improvements in precision are unlikely to be productive.

A statistically simpler and more robust method to achieve greater precision is to stratify the survey areas appropriately. Currently in the case of trawl surveys, they are based on spatial management areas and depth. For the more commonly caught species, spatial distribution is both persistent at smaller scales than the stratification and patchy, with some areas consistently yielding bigger catches than others within management areas. More appropriate stratification would include these differing abundance trends either as nested strata within a region, or across regions. If the within strata likelihood contributions were to be larger in some areas than others, additional sampling effort can be used to reduce the variance. This approach is effective, but is unlikely to serve a group of species differentially dispersed across an ecosystem, in which case the earlier mentioned generalized model approach would be preferable.

Length and age data

Information on proportions at age and at length is used in a number of the assessments. Generally their use is mutually exclusive for a single source of information, for example a survey or catch per unit effort (CPUE). Length information is used directly, whereas age information is applied through an age–length conversion matrix, usually including some estimated probability for ageing error. Generally, age determination by the break-and-burn technique is considered to be reproducible (across different readers) and for some species the validity of the estimates has been verified radiologically. For older, deeper living species, especially thornyheads, ageing appears to be even more problematic, so less is known about the exact growth rates. Data from tagging experiments examined at the workshop suggest that many of the individuals tagged have already attained their maximum size, so information based on those fish proved to be more useful in determining L_{inf} than k. It was suggested that this method then provided little hope for estimating growth. However, there is a direct correlation between the size at tagging of an individual and the growth interval between tagging and recapture, so it is not the method, but rather the individuals that had been tagged that were inappropriate for estimating growth rates. Smaller individuals have significantly more scope for growth than large fish, so information based on such fish can be much more informative. Moreover, the trawl survey catches sufficient numbers of small thornyheads to make such work more effective. Future tagging needs to concentrate on these smaller fish to maximise the information they return.

b. Evaluation of analytical methods used in assessments, particularly in regard to selectivity, selection of age and length bin structures, data weighting assumptions, and assumptions and modeling of trawl and longline catchability.

Age-based assessments

Tier 3 stocks are assessed using statistical catch-at-age methods formulated in AD Model Builder (ADMB). The likelihood-based approach is state of the art and recognised as such worldwide, with many institutes following similar approaches. The great advantage of the methodology in general is its ability to compare variability objectively on a universal scale and hence to carry assessment uncertainty appropriately through to the management measures used to assess stock status and make forecasts.

The literature provided suggests that there has been an attempt to provide a single ADMB template file for all age-based rockfish assessments, but that this appears not to have been fully implemented yet. Structurally though, the models are similar and based on the same original template file, with different options added to different assessments. A single quality-controlled template would be an advantage if only to ensure numerical correctness through quality control. There were discussions at the review meeting of the use of other more formal assessment tools, particularly stock synthesis (SS3), because it is assumed that it undergoes more rigorous QA/QC procedures prior to release. My personal feeling is that the ease with which errors can creep in as a result of complexity in the data and control files in SS3 outweighs the advantages of QA/QC for those that do not frequently use the software. In addition, there are anomalies in the implementation that are poorly understood and documented that have led to divergence between what was done and what was intended. Such errors are technically more difficult to spot than straightforward calculation errors. Consequently, I understand the reasons for, and support the use of, the custom model approach. I also agree with the SSC that use of a universal rockfish template would be advantageous over the longer term.

The amount of diagnostic information provided in the literature made available prior to the meeting was limited, and there was insufficient time at the meeting to examine all the assessments in detail, so the comments in this review focus on the BSAI population assessment that was discussed in detail during the meeting, with additional diagnostics being provided. The comments are mostly specific to that assessment, but similar problems appear to exist in a number of the other age-based assessments, although the specifics vary. Further work needs to be conducted prior to the next review to resolve or at least to understand better the reasons for these issues. Given the successful review and application of these models in the past in informing management, it seems reasonable to assume that the models themselves, most of which are largely unchanged, continue to provide advice to managers that can ensure that stocks are exploited sustainably. However, it may be possible to increase the accuracy and precision of some of the reference points, which in time might allow more optimal exploitation of the stocks.

Systematic residual patterns in age-information

The uncertainty estimates from the assessment are based on the scale of the residuals. This assumes an underlying random distribution of residuals across all data, although the Markov chain Monte Carlo (MCMC) sampling used to assess uncertainty does so by conducting a random walk across the parameter estimates and as such does not resample the residuals. Nevertheless, the step changes in parameters are guided by the likelihood function, so that the effect of systematic biases in residuals on the uncertainty of management quantities remain the same as those that might be expected from a delta-method bootstrap resampling.

The BSAI population assessment demonstrates a less-than-random distribution of residuals in the age composition data that are indicative of some process error in the model. The definition of “less-than-random”, of course, is subjective, but some of the comments below may not be considered significant departures from random by certain practitioners.

The proportion of fish older than age 30 years and specifically the plus group in the survey information is strongly underestimated by the model for the first four surveys, and is roughly consistent with the survey estimates in the following two surveys. However, for the remainder of the time-series, there are fewer plus group fish than expected by the model. When the age compositions are multiplied by the abundance estimates, the discrepancies become even more apparent. The survey estimates of abundance at plus-group age are roughly 10× those estimated by the assessment model, and roughly double over the whole period. In contrast, the modelled abundance of the plus group quadruples over the survey period, suggesting a greater increase in biomass than supported by the survey. Ages 15–30 are in good agreement in the model and the survey, whereas the younger ages are more abundant in the model in the early part of the survey time-series relative to the survey series, with the opposite being true in the later part.

Credibility of SSB F and recruitment trends

A more-detailed examination of the modelled stock dynamics suggests that historically high estimates of F have removed a large proportion of the older ages from the population, and by the time the survey series starts, cohorts are beginning to swell again in response to the reduced fishing mortality. In contrast, the survey series suggests that the reduction in the oldest cohorts has not been as severe. In fact rockfish ages of 30+ show very little change in abundance in the survey over time, and yet these cohorts are the very ones that should have received maximal exploitation being exposed to high fishing mortalities at full selection (30–40 year olds in 1980 would have been aged 15–25 at the time of the estimated peak F). By contrast, cohorts 30–40 years old in 2010 would have been fully selected only since about 1980, the time when period fishing mortality is estimated to have been at its least. The model compensates for this by assuming that the recruitment since 1980, i.e. the exact year the survey started, and earlier has no age information is available in the assessment at all. The exception to this are two exceptional cohorts (1957 and 1962), which are predicted to have sustained the population during the period of large catches. However, neither the survey nor the fishery has any evidence to support the existence of such large cohorts in the age information since 1980, and even if they had been fished extremely hard and are now rare, they should still be prominent relative to adjacent cohorts.

Given this lack of cohort signal, it is my opinion that the recruitment estimates for years prior to 1980 are rather suspect and that parameterising a variable selectivity (alpha 50%) prior to this period as currently implemented in the model is inappropriate. The model needs these very strong recruitments to sustain the populations in light of the large catches during the 1960s, and despite this, the population declines to around 10% of its 1960 level in about 15 years. Therefore, the existence of these cohorts is crucial to the credibility of the SSB trend. It seems that a declining SSB during the period of large catches is very likely, but I think the magnitude of that decline is exaggerated by the model suggesting in the end that significantly bigger catches than suggested by the ABC would be sustainable from a mixed population with the growth and mortality characteristics of this stock.

However, if mixing is as limited in the BSAI stock as suggested by genetic information (see TOR d) and the stock had declined to 10% of its 1960 biomass, as suggested by the assessment, it is certain that the stock would not have been able to recover in the time predicted. Moreover, if the stock had been as unevenly distributed as it is now, exerting heavy fishing mortality in the early part of the period on dense aggregations would have been easy, but maintaining such high levels of F when the remaining fish were more dispersed would have been impossible without an exponential expansion of the fleet in the 1970s, for which again there is no evidence. Therefore, ignoring the increased risk of managing a less than fully mixed population is more than compensated for by overly conservative recent catches. As a consequence, resultant management appears to be stable, but a better assessment model and more advanced information of the extent of segregation within a population might suggest that bigger long-term catches could be sustainable. Whether such an expansive body of work is economically feasible for what could potentially be a small increase in yield under a significantly more complex management regime in order to deal with the lack of mixing is a more difficult question to answer.

Catch curves

The model data presented in the assessment (biomass and percentage age composition) do not easily lend themselves to the evaluation of catch curves. However, during the review workshop, the survey data as catch-at-age for the BSAI population were made available, allowing for examination of catch curves. The data indicate that after age 15, selectivity stabilises sufficiently to estimate total mortality. Estimates of total mortality Z for individual cohorts are highly variable, but averaging over the period yields estimates in the region of 0.03–0.09, depending on the ages or periods chosen. Having an estimate of Z close to the level of M assumed in the assessment despite low but persistent catches in recent years means that the assessment has to assume that biomass is currently large. Consequently, the latter conclusion is very much dependent on the strongly constrained parameterisation of M. An unconstrained M would lean towards much higher levels of M with a commensurate change in survey selectivity to a less steep increase and a shift to older ages in order to account for the apparent lack of a steeper decline in catch-at-age. Although such a model does not appear to be an appropriate alternative to the recommended one, it does deal more adequately with the excess of fish of the plus group encountered in the survey. One alternate scenario that may prove useful to investigate is one of size-/age-specific M. Given that the stock appears to reach asymptotic length at an age roughly commensurate with the age at which the obvious declines in catch-at-age in the survey data dissipate, such an approach may be able to reconcile the more appropriate survey selectivity with the significant abundance of plus-group fish. Dome-shaped fishery selectivity would tend to have a similar effect and may also prove fruitful to investigate, although more work would be required to ascertain what might cause this effect operationally in the fishery in a stock where spatial movement and spatial age-disaggregation is common. For example, if the larger aggregations are made up of younger fish, then fishermen targeting areas of high CPUE might well have find a lower selectivity for older fish.

Plus-group age

For a number of the age-based assessments presented this year, an analysis has been carried out to investigate whether an increase in plus-group age would be a useful approach to gain the maximum information content from the data. For most of the stocks, the result was an increase in the likelihood function commensurate with the increased number of parameters being estimated, while the residual mean squared error remained comparatively stable. Interestingly, at least one of the models tested did not converge, suggesting that there is some instability in the model. There therefore seems to be little benefit in investigating an increase in plus-group age at least until the residual pattern issue has been resolved. Given the abrupt cessation of growth, there is no information content on age based on length information in the length plus group, so there appears to be little benefit either in changing the length group structure.

Weighting of the likelihood function

The idea behind using a likelihood-scaled penalty for all data sources is to retain the objectivity in the model parameterisation. Here, multipliers have been selected in order to balance the information going into the model, and the choice of multipliers is (a) not explained/justified in the assessment, (b) differs between models, and (c) very restrictive with respect to catch. I am not averse scientifically to subjective weighting, in fact I do believe that the appropriateness and relevance of certain data sources cannot be judged by statistics alone. However, the model uncertainty reported should include the uncertainty caused by the weighting or at least demonstrate the effects of the weighting. In this case, a very high penalty is placed on the catch estimates to ensure that the assessment is consistent with management and reporting because it is felt that this is the most accurate of the data sources. However, when including discard data and catch composition issues and reconstructing historical catch information, such strong forcing may not be appropriate, at least not for the entire time-series.

In contrast, age information appears not to be weighted heavily enough in the models, with several models missing cohort signals in both the catch and the survey information, or in the case of the BSAI population, predicting large cohorts where there is no age evidence for them. The model treats the survey biomass entirely independent of the survey age composition (the latter being introduced as a proportion).

In my mind, though, the two are not independent. The survey biomass observed is made up of a combination of fish of a certain age. The example of the BSAI population plus group is a good example. The likelihood residuals for the plus group are small on a multinomial scale because of the large number of ages in the assessment, and there is little effect on the biomass estimates from the incorrect assignment of some of the ages. However, if the information is examined at the scale of numbers at age, then the effect becomes much more apparent, being biased persistently by an order of magnitude. The dependence between biomass and age composition arises at the level of the sample (not all samples have age information), but of course the biomass estimate as a whole is made up of the sum of the sample estimates. From a likelihood perspective, the information needs to be entered at the sampling level, i.e. what is the probability of attaining the age structure if it is based on a subsample of ages from an individual sample. In other words, the effective sample size weighting in the likelihood needs to be done by sample and not across the sum of the survey.

In its current form, I believe that the age information is under-represented in the likelihood, a situation worsened by the strong adherence to catch information. This is exemplified too in some of the other age-based assessments where cohorts clearly above average size in the majority of surveys are smoothed through in the predicted age compositions because there is no appreciable effect in the catch and biomass trends. This could be because the modelled dynamics have process error (see section on residuals above) or because the age compositions are undervalued in the assessment tending towards a biomass production model. This is not necessarily wrong, but given the effort expended on age information there must be some belief that this information is of more value than appears to be taken up effectively in the current assessments.

One effect that appears in other age-based assessments, but is not apparent in the BSAI population assessment, is the fact that the age groups just before the plus group tend to be overestimated in the models. Apparently this used to be an issue in the BSAI population assessment and was traced back to the ageing error conversion matrix which did not deal appropriately with the fact that ageing errors in the plus group progressively diminish as the age of the fish moves up into the plus group. This issue needs to be addressed in the other models and checked as to whether it resolves the symptoms.

Dome shaped selectivity:

For GOA Pacific ocean perch, age composition data provide good evidence of a shift in selectivity from logistic to dome-shaped over time. This evidence is supported by the development of the fleet, especially the movement to shallower waters in recent years. What is less clear is whether there is an ontogenetic offshore movement at ages consistent with this shift. The data indicate that the selectivity at plus-group age is around 0.2, whereas the model predicts this to be close to zero, despite there being some catches in this group.

Is it credible that there are no plus-group fish present in the area currently exploited? Could other factors such as spatially restricted exploitation have removed these older fish from isolated populations, whereas the survey still picks them up in less exploited areas, leading to the apparent contrast in selectivity? Alternatively, could lower levels of M at older ages explain the discrepancy between the data and modelled selectivities? It may be possible to use the survey data to investigate the depth distribution of plus-group fish to confirm that they are outside the exploited depth strata, but at least the sensitivity of management should be investigated with respect to these possibilities for the next assessment review, especially so given the link between selectivity and catchability and in turn the documented correlation between catchability and M in the model.

c. **Evaluation, findings, and recommendations on the analytical approach used for "data-poor" rockfish stocks and complexes, including the use of an age-structured model for a two-species complex, and application of state-space production models to stocks and stock complexes.**

Tier 4 and 5 assessments

The large number of rockfish species, especially when divided into their component stocks, potentially renders their assessment and management very labour-intensive. Given the spatial and temporal segregation of species, it is also unlikely that assessment needs can be served by a single survey even if funding was available to extend the current work. It is therefore likely that a number of rockfish stocks will continue to be assessed at a tier level greater than 3. Furthermore, where precise species identification requires genetic analysis this will require assessment at the species complex level. The need to better manage the so called “data-poor” stocks has led to the development of a number of different approaches that either are used already or are being developed.

Age-structured model for 2-species complex

The inability to identify species properly does not represent a problem for an age-structured assessment *per se*, and after all, an age-structured assessment is merely an accounting methodology. In that sense, the difficulty is in the management application of the data and whether traditional single-species reference points are sufficient to conserve multi-stocks. Ideally, for this approach to be consistent with traditional management reference points, the biological characteristics and catchabilities of the species should be similar (i.e. the species should co-occur). If the parameters differ, the model will require some information on the relative contribution of the species characteristics to the average parameter and/or allow for the parameter to change over time. The application of a state-space biomass production model is relatively hopeless in estimating the response of the stock to exploitation. The problem is not the application of the Kalman filter approach, but rather the use of a production model assuming some relationship between SSB and population growth when the data series is short, with very little contrast in SSB, and the species is long-lived, i.e. there is no information on the parameter ‘a’.

The group discussed additional work that might help in determining the initial aggregate parameter estimate in the biomass production model (‘a’), which to my mind is not feasible given the lack of contrast in SSB. Even if there were contrast, this information would provide no guidance to the model of how ‘a’ would change over time as the species composition altered under exploitation. Especially for coarse complexes such as the ‘other rockfish’ complex, where the response would be highly unpredictable, it seems unlikely that the model would be sufficiently responsive to provide appropriate management advice at the current reference points.

The random walk model makes no assumption about population growth and therefore has a more rapid response, so given that for other rockfish species, stock–recruit relationships are generally rejected, it is likely to be a more appropriate model. With additional refinement, such as potentially including some occasional estimate of commercial catch composition by species in some years to stop model drift through cumulative process error, it should be possible to manage the fisheries using this approach. Whether the current management reference points are sufficiently precautionary to deal with the additional uncertainty in the extent of mixing as appears to be the case in the single-species stocks is uncertain. Safe application would require further study or close monitoring during the development of the management approach under the new model. Certainly, because it uses significantly more of the available information, it seems better than using solely the survey data and an assumption of q =

1 irrespective of whether the final year's survey or some other form of average is used. At the moment, it is still not clear to me how the model differentiates between zero catches in the survey and no survey, and this issue needs to be investigated or better explained to make sure the uncertainty is treated appropriately in the model.

In the meantime, species sampled with high variability in the survey are unlikely to respond as expected to the implementation of annual catch quotas that are more likely to track variability than changes in population abundance and hence encourage discarding. Here, it may pay to provide some form of longer-term risk assessment with robust management measures in relation to the species biology and current understanding of the fishery dynamics.

d. Evaluation, findings, and recommendations on the adequacy of current levels of spatial management, including apportionment strategy.

The issue of spatial management arises because populations of rockfish are spread over a vast tract of the ocean from the GOA out to the Aleutian Islands. Rockfish are not thought to undergo mass migration and even movement of individuals appears to be limited, so there is potentially significant population isolation which would render the stocks more sensitive to exploitation than would be the case if the stock was totally mixed. Certainly, some very deep channels between some of the islands along the chain appear to preclude free movement of individuals over the range of the stock.

Tony Gharrett provided a detailed presentation on the current knowledge of rockfish genetics. In general, sampling for genetics continues to be sparse, precluding full understanding of the extent of mixing within the population. Persistent differences between areas over time suggest that there are distinct subpopulations within the Pacific ocean perch stock in the GOA, based on the juveniles sampled. This is despite what appears to be a prolonged pelagic phase during larval and post-larval development. The suggestion is that population isolation is maintained through oceanographic conditions such as eddies, but what is less clear is how these populations can be self-maintaining unless adults migrate to spawn at sites that ensure that the currents can return juveniles to the population.

From a knowledge of genetic diversity, it is possible to determine average movement in a generation. This appears to be <500 km for most species of rockfish. Unfortunately, the distance moved is inversely proportional to population size, which in this case was taken from the assessments. If populations were significantly smaller, then one would expect more mixing over greater distances. Interestingly, if more were known about the actual distance migrated by individual fish, that information could be applied in reverse to determine the population size to at least scale the biomass estimates in the assessment appropriately. It is that scaling that is usually a significant source of uncertainty because of the difficulty in estimating M.

Currently, tagging of rockfish to attain better information on individual movement is not possible because of the effects of barotrauma, but future developments in tagging technology (e.g. self-tagging, where the fish take the tag as they would take bait from a line) may make this possible. Otolith trace element analysis may also not be applicable here because of the lack of contrast in concentrations of elements in the environment. This approach therefore appears to be some way off delivering the required information on movements.

A simulation study on genetic diversity under different levels of exploitation presented by Ingrid Spies suggests that economic exploitation is likely to be more limiting than concerns with respect to genetic diversity. However, that study assumes a redistribution of effort in response to changing subpopulation densities, given a penalty for distance from port. Whether the ideal free distribution assumption is appropriate for modelling fisher behaviour for target fisheries is questionable, but certainly for the blackspotted rockfish, it is inappropriate because the species is taken only as a bycatch in the Pacific ocean perch fishery. The results for blackspotted rockfish would therefore likely be somewhat of a response to changes in the abundance of the target stock. The model presented is therefore of limited use in addressing the question of appropriate spatial management for non-targeted stocks, and for targeted stocks it confirms the concerns that a stock containing isolated populations is more susceptible to localised exploitation than a fully mixed stock.

Despite the uncertainty over the extent of mixing, it is very likely that some degree of subpopulation isolation exists in several if not all rockfish stocks. Not knowing how isolated the subpopulations are, however, it is impossible to assess whether the current form of spatial management is sufficiently precautionary. Certainly, the current management areas where assigned to stocks are roughly twice the size of the generational migration distance suggested by genetics, suggesting that spatial management may be insufficiently detailed to avoid localised overexploitation at the stock-wide estimate of sustainable fishing mortality. In addition, it seems unlikely that fisheries and survey information will be available in future to develop population-specific assessments, so it is highly unlikely that it will become possible to exploit the entire stock at its maximum sustainable level, nor would such management really be practical. Therefore, the current approach of monitoring the distribution of catches by management area in conjunction with what is seemingly a precautionary approach to management overall seems to be the most suitable regime to ensure conservation of stocks, but it is still likely to forgo some potential yield.

What could be improved is the way that catches are allocated to the various regions, at least in theory as related to exploitable abundance. However, the latter parameter is based on survey estimates, which may or may not (because of differences in selectivity) be linked to the exploitable population. Also, within regions the distribution is not even either, with some peak abundances found in relatively restricted areas; preferential removal of these aggregations may have effects on stock productivity even if the catch is replaced by inward migration over time because such inward migration is certainly not going to be immediate. Better understanding of what drives this spatial variation in abundance would certainly help (see section on improving the indices), but better direct monitoring of vessels on a smaller time-scale (using VMS) especially for those stocks that are not necessarily target species would help to ensure that effort remains evenly distributed across the resource, or at least can highlight conservation concerns.

The measure used for apportioning the ABC to different regions should be consistent with the measure used in setting that ABC, for example setting the ABC on the basis of the last year's exploitable population estimate, but use of the average composition over the past three surveys would seem to me to be inappropriate. The reasons for this inconsistency in management were not clear to me at the review workshop, and I can merely assume that it was concerns over the variability in the population survey estimates that led to the use of the average value for spatial allocation. Nevertheless, there is no reason to assume that averaging across populations increases the precision of the estimate when variances are independent. In my opinion, therefore, this would serve only to increase the risk beyond the inherent level associated with setting the global ABC in the first place. Currently there appear to be some inconsistencies in the way this issue is managed.

For stocks with high variability in the survey series, especially those managed in complexes because the data are insufficient to perform management on a single-species level, it seems unlikely that annual management measures can provide effective management. It may pay, therefore, to provide some form of longer-term risk assessment with robust management measures in relation to the species biology and current understanding of the fishery dynamics rather than attempting to implement annual catch quotas that are more likely to track variability than changes in population abundance and hence encourage discarding.

RECOMMENDATIONS

a. A more detailed examination of the persistent residual patterns in the assessment especially with respect to the plus group age needs to be conducted and attempts made to find model formulations that result in a lesser degree of process error.
b. Habitat or environment based models should be investigated (GLM or GAM) to determine if it is possible to significantly increase the precision of survey biomass estimates by accounting for the differences in habitats sampled between years due to the random sampling design. For this work an improved understanding of the spatial distribution of habitats and the environmental conditions found there is necessary and multi beam and oceanographic collections are encouraged to achieve this.
c. More work should be conducted to better understand the mixing dynamics of the stocks. Most important here is to expand the work to a wider set of species and to see if the conclusion derived for the GOA hold in other areas.
d. A better understanding of the spatial distribution of fishing effort is required to ascertain if the differences in catches between management regions are due to different abundances or an uneven distribution of effort. This is important both in relation to evaluating CPUE data and to determine the impacts of the reduced mixing effect discussed in the previous recommendation.

e. The simulation testing work being done by the Plan Team working group on managing many spatially disaggregated stocks by complex should continue.
f. Improve assessment documentation: (1) provide a bridging analysis to the most recent previous stock assessment if age or length-based (2) provide a more comprehensive diagnostics of model fits including residual plots (3) provide sensitivity analyses for all major assumptions of the stock assessment on both the contribution of all likelihood components, the values estimated by the model, and also principal management outputs such as ABC values.
g. Concentrate tagging work on small thorny heads and other species amenable to tagging as these individuals are likely to be much more informative on growth than the larger individuals which have ceased to grow. This work may also produce an improved understanding of the movement of individuals.
h. Conduct maturity studies both to increase sample sizes and hence precision estimates as well as increase the number of stocks covered so that a greater number of stocks can be considered for Tier 4 classification.

COMMENTS ON THE REVIEW PROCEDURE

The review meeting, presentations and information provided were well structured in accordance with the terms of reference set for the meeting. However, because themes were discussed across assessments individual assessments were much more difficult to follow. Assessment documents were prepared for managers, rather than for a full scientific review generally lacking with respect to diagnostics to determine the characteristics of the model. Therefore the review mainly focused on the principle of the methodologies or data sources, rather than the suitability of the model in a specific case.

For me there was only opportunity (time and data availability) for me to examine BSAI Pacific ocean perch stock in greater detail. The more detailed investigation suggested that there were persistent biases in the assessment. Although not likely to severely hamper management or endanger conservation the shortcomings warrant further examination. It was not possible to make the same assessment of the other age based assessments though it was clear that some of these also showed similar symptoms of systematic residual patterns.

If a greater level of detail for the suitability of assessment is sought by the SSC, it would be better in future to reduce the number of general management questions and relate TORs to a smaller number of specific assessments as is common amongst other SSCs. If the more general approach is desirable it would help to make this clearer in the TORs as I certainly struggled trying to bridge the gap.

It would be of interest to me to better understand the dynamics of the fleet in the case of rockfish and at other reviews I have always found the understanding and historic information of fishermen and stakeholders useful and interesting. I would find it useful if some representation of stakeholders could be encouraged, although I certainly understand that the SSC has relatively little influence addressing such a request.

REFERENCES

Faunce, C.,H. 2011. A comparison between industry and observer catch compositions within the Gulf of Alaska rockfish fishery. ICES J. Mar. Sci 68:1769-1777.

Appendix 1: Bibliography of materials provided for review

Background and management:

Growth and production of juvenile Pacific ocean perch. 2012. Juveniles in nursery habitats are examined with bioenergetic and habitat models.

Ecological analysis of rockfish assemblages. 2008. Five assemblages of rockfish identified with environmental data.

BSAI and GOA rockfish overview. A 2005 council-prepared overview of rockfish management in Alaska.

Northern rockfish biology. 2002. A review of the fishery and biology of northern rockfish.

Review of Sebastes Taxonomy. 2000. A historical analysis of the origin of *Sebastes* lineage.

Survey design and habitat:

An experimental acoustic trawl survey for rockfish. 2012. A field application of an "on-the-fly" stratification using acoustics for POP.

Simulation of a trawl-acoustic survey design. 2012. Evaluates a trawl-acoustic survey design for estimating abundance of patchily-distributed species.

Habitat-based estimation of abundance. 2012. Models trawl survey data for rockfish and uses habitat variables to predict abundance for 5 species.

Abundance of rockfish in untrawlable habitat. 2012. Attempting to address untrawlable grounds issue with multiple technologies.

Estimating species and size composition of rockfishes. 2012. Using an ROV and a drop camera to verify acoustic targets.

Seabed classification for trawlability. 2012. Using multibeam echosounders to generate metrics that describe the seafloor.

Habitat utilization by rockfish using acoustics and cameras. 2010. Evaluates juvenile rockfish abundance in rocky habitat.

Non-random error in trawl surveys. 2007. Short communication about untrawlable grounds by P. Cordue inspired by last CIE review.

Sampling rockfish populations. 2004. Book chapter on adaptive sampling, hydroacoustics and other methods for sampling rockfish.

Applications in adaptive cluster sampling. 2003. Results of two survey design experiments focusing on GOA Pacific ocean perch and Shortraker/Rougheye.

Rockfish assessed acoustically. 2001. Linear regression approach looking at raw acoustic data versus trawl catches for rockfish.

Reproductive biology:

Reproductive biology in the Aleutian Islands. 2013. New publication for Pacific ocean perch and northern rockfish in the AI.

Incorporation of reproductive dynamics into stock assessments. 2013. The effects of relative fecundity, and maternal effects in larval survival, on estimated productivity.

Relationship of maternal age and size to fecundity and timing. 2013. Quillback rockfish are examined for higher energy reserves in older females.

Summary of maturity information used through 2010. 2010. White paper describing the maturity data for rockfish in the Gulf of Alaska.

Maternal age effects on harvest policy. 2007. An analysis of implications on harvest policy of higher larval viability in older rockfish.

Stock structure and genetics:

Report of the stock structure working group and template. 2010. Plan Team guidance white paper on stock structure.

Stock structure analyses. 2010-2012. Application of stock structure template to GOA POP, dusky, and rougheye/blackspotted rockfish.

BSAI Northern rockfish stock structure. 2012. Application of stock structure template to BSAI northern rockfish.

BSAI blackspotted and rougheye areal exploitation rates. 2012. Application Update to 2010 stock structure report.

BSAI blackspotted and rougheye stock structure. 2010. Application of stock structure template to the BS/RE complex.

Northern rockfish genetics. 2012. Genetic analysis suggests limited lifetime dispersal.

Geographic structure in POP. 2011. Genetic analysis suggests limited lifetime dispersal.

Naming of blackspotted rockfish from rougheye complex. 2008. One of the papers leading to split of rougheye into rougheye and blackspotted rockfish.

Localized depletion 2007. Analyzes possibility of short and long-term localized depletion for three species of rockfish.

Evidence for sibling species of rougheye rockfish. 2007. One of the papers leading to split of rougheye into rougheye and blackspotted rockfish.

Genetic variation of rougheye and shortraker. 2005. Allozyme study for two species of rockfish.

Separation of dusky rockfishes. 2004. Formerly one species informally called light and dark rockfish are now *S. variabilis and S. ciliatus.*

Population structure of shortraker rockfish. 2004. DNA microsatellite variation shows some large-scale structure in shortraker rockfish.

Modeling and data:

Effective sample sizes on age comps 2. 2012. Using the GOA POP model to look at iterative reweighting and sampling theory to weight age and length compositions.

Effective sample sizes on age comps 1. 2011. Using the GOA POP model to test various likelihoods and sample size weightings.

Modeling thornyhead abundance with a two-stage model. 2009. Gulf of Alaska survey data is modeled with environmental data for thornyhead rockfish.

Kalman filter method for rockfish. 2005. Application of a Kalman filter method to a multi-species complex of Tier 5 stocks.

Catch composition. 2011. Study comparing industry and observer reported catch compositions in the rockfish fishery.

Publication describing generalized rockfish model. 2007. The paper also compares some sensitivities of the model between different GOA species.

Other regions' rockfish assessments

West Coast U.S. POP. 2011.

Canadian POP. 2001.

Appendix 2: Statement of work

Attachment A: Statement of Work for Dr. Sven Kupschus (CEFAS)

External Independent Peer Review by the Center for Independent Experts

Review of Alaska Rockfish Assessments

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: The Alaska Fisheries Science Center (AFSC) is responsible for stock assessments for 13 rockfish stocks and stock complexes. Collectively these rockfish stocks support valuable commercial fisheries. The last time rockfish stocks were independently reviewed by the CIE was in 2006. Several changes have occurred since that time. New assessments have been developed, several existing assessments have been modified to include new life history information, and the fisheries in the Gulf of Alaska have been rationalized allowing more stocks to be fully utilized. Some assessments have implemented or explored modeling changes such as time-varying selectivity or iterative reweighting of data sources to achieve better variance specification. New information has become available on the spatial population structure of rockfish, which has affected the assessment and management of these species and raised questions if the current spatial management is adequate. In addition, fish formerly identified as rougheye rockfish (*Sebastes aleutianus*) are now known to comprise two species which are assessed together in one age-structured stock assessment model because of misidentification problems. These issues underscore the need for an independent review of rockfish resources in the Gulf of Alaska and Bering Sea/Aleutian Islands.

In addition, there are several stocks that are commercially valuable, but are currently only assessed using survey biomass estimates with reference points based on natural mortality. These stocks often have other demographic and life history data available such as length compositions or maturity estimates, but lack reliable age data. The AFSC would benefit with a review of the current methods for "data-poor" rockfish stocks and recommendations for improved methods.

Alaska rockfish assessments rely strongly on trawl survey biomass estimates, and the previous CIE review identified the need for focused research on the fraction of the stock that resides in untrawlable grounds in order to characterize any potential bias and/or imprecision resulting from expansion of fish densities from trawlable areas to untrawlable areas. Since 2006, scientists at the AFSC have conducted experiments to assess the fraction of the rockfish stocks that reside in untrawlable substrate. A review of this research and recommendations for how to incorporate the results into stock assessments is needed.

Finally, the AFSC longline survey provides a relative population index for several species of Alaska rockfish (~1990-present). This index is currently used in the Gulf of Alaska rougheye rockfish population model, but has potential to be incorporated into other rockfish assessments such as shortraker rockfish (Sebastes borealis). The AFSC would benefit from a review of the current methods for incorporating this index into stock assessments and recommendations for new or improved methods.

The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein. CIE reviewers shall have the expertise, background, and experience to complete an independent peer review in accordance with the SoW and ToRs herein. CIE reviewer expertise shall have expertise and work experience in analytical stock assessment, including population dynamics, age/length based stock assessment models, data-poor stocks, survey design, and population structure and spatial management. In order to help ensure an independent review, we request three reviewers who did not serve as reviewers in the 2006 Alaska rockfish CIE review.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled during April 9-11, 2013 at the Alaska Fisheries Science Center in Juneau, Alaska.

Statement of Tasks: Each CIE reviewers shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

<u>Prior to the Peer Review</u>: Upon completion of the CIE reviewer selection by the CIE Steering committee, the CIE shall provide the CIE reviewer information (name, affiliation, and contact details) to the Contract Officer Representative (COR), who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and information concerning other pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

AFSC will provide copies of the statement of work, stock assessment documents, prior CIE review documents, and other background materials to include both primary and grey literature.

This list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables. Furthermore, the CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein.

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review;
2) Participate during the panel review meeting at the Alaska Fisheries Science Center in Juneau, Alaska during 9-11 April 2013 as called for in the SoW, and conduct an independent peer review in accordance with the ToRs (Annex 2);
3) In Juneau, Alaska during 9-11 April 2013 as specified herein, conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than 26 April 2013, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to David Die ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2;

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

March 1, 2013	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
March 25, 2013	NMFS Project Contact sends the CIE Reviewers the pre-review documents
April 9-11, 2013	Each reviewer participates and conducts an independent peer review during the panel review meeting
April 26, 2013	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
May 10, 2013	CIE submits CIE independent peer review reports to the COR
May 17, 2013	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be made through the COR who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions. The COR can approve changes to the milestone dates, list of pre-review documents, and Terms of Reference (ToR) of the SoW as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToRs and deliverable schedule are not adversely impacted. The SoW and ToRs cannot be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COR for final approval as contract deliverables based on compliance with the SoW. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (the CIE independent peer review reports) to the COR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards: (1) each CIE report shall have the format and content in accordance with Annex 1, (2) each CIE report shall address each ToR as specified in Annex 2, (3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon notification of acceptance by the COR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COR. The COR will distribute the approved CIE reports to the NMFS Project Contact and regional Center Director.

Support Personnel:

William Michaels, Program Manager, COR
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-427-8155

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Key Personnel:

Paul Spencer, Project Contact
NOAA National Marine Fisheries Service, Alaska Fisheries Science Center
7600 Sand Point Way, NE, Bldg 4, Seattle, WA 98115

paul.spencer@noaa.gov Phone: 206-526-4248

Philip Rigby, Marine and Ecology and Stock Assessment Program Manager
NOAA National Marine Fisheries Service, Alaska Fisheries Science Center
Auke Bay Laboratories, 17109 Pt. Lena Loop Rd., Juneau, AK 99801
Philip.rigby@noaa.gov Phone: 907-789-6653

Steven Ignell, AFSC Deputy Science and Research Director
NOAA National Marine Fisheries Service, Alaska Fisheries Science Center
7600 Sand Point Way, NE, Bldg 4, Seattle, WA 98115

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a detailed summary of findings, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include as separate appendices as follows:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work
   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

Review of Alaska Rockfish Assessments

CIE reviewers shall address the following Terms of Reference during the peer review and in the CIE reports.

a. Evaluation of data used in the assessments, specifically trawl and longline survey abundance estimates, and recommendations for processing data before use as assessment inputs.
b. Evaluation of analytical methods used in assessments, particularly in regard to selectivity, selection of age and length bin structures, data weighting assumptions, and assumptions and modeling of trawl and longline catchability.
c. Evaluation, findings, and recommendations on the analytic approach used for "data-poor" rockfish stocks and complexes, including the use of an age-structured model for a two-species complex, and application of state-space production models to stocks and stock complexes.
d. Evaluation, findings, and recommendations on the adequacy of current levels of spatial management, including apportionment strategy.
e. Recommendations for further improvements

Annex 3: Tentative Agenda

Review of Alaska Rockfish Stock Assessment

Alaska Fisheries Science Center, Juneau, AK

April 9-11, 2013

Contact for security and check-in: Phil Rigby
Contacts for additional documents: Paul Spencer/Dana Hanselman

Tuesday, April 9:
9:00 AM – 10:30 AM: **Introduction**
Topics:
Introductions and the agenda, overview of rockfish biology, fishery, and history of assessment.

10:30 AM – Break
10:45 AM – Discussions
12:00 PM – Lunch
1:00 PM -3:00 PM: **Input data**
Topics:
Survey data – Abundance indices, ages, lengths, growth
Fishery data – Catch, ages, lengths, and observer data

3:00 PM – Break
3:15 PM – **Discussions**
5:00 PM – Adjourn for day

Wednesday, April 10:
9:00 AM – 10:30 AM: **Assessment model**
Topics:
Model structure, likelihood formulations, data weighting

10:30 AM – Break
10:45 AM – **Discussions**
12:00 PM – Lunch
1:00 PM -3:00 PM: **Parameters, priors, and ages**

Topics:
Catchabilities, selectivities, natural mortalities, recruitment variability

3:00 PM – Break
3:15 PM – Discussions
5:00 PM – Adjourn for day

Thursday, April 11:
9:00 AM – 10:30 AM: **Current issues**
Topics:
Spatial management, areal apportionment of catch, overfishing limits

10:30 AM – Break
10:45 AM – Discussions
12:00 PM – Lunch
1:00 PM -3:00 PM: **Alternative model runs, further discussion as needed**
Topics:
TBA

3:00 PM – Break
3:15 PM – Further discussions and summarize
5:00 PM – Adjourn meeting

Appendix 3: Panel Membership or other pertinent information from the panel review meeting

Participant	Program	Center	Agency
Dana Hanselman	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Kalei Shotwell	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Chris Lunsford	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Jon Heifetz	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Phil Rigby	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Pete Hulson	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Cindy Tribuzio	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Katy Echave	Marine Ecology and Stock Assessment	Alaska Fisheries Science Center	NOAA
Paul Spencer	Resource Ecology and Fisheries Management	Alaska Fisheries Science Center	NOAA
Ingrid Spies	Resource Ecology and Fisheries Management	Alaska Fisheries Science Center	NOAA
Jim Ianelli	Resource Ecology and Fisheries Management	Alaska Fisheries Science Center	NOAA
Chris Rooper	Resource Assessment and Conservation Engineering	Alaska Fisheries Science Center	NOAA
Jane DiCosimo*	Plan Coordinator		North Pacific Fishery Management Council
Tony Gharrett	Fisheries Division	School of Fisheries and Ocean Sciences	University of Alaska Fairbanks
Sven Kupschus	CIE review member	Cefas, UK	
Cathy Dichmont	CIE review member	CSIRO, Australia	
Neil Klaer	CIE review member	CSIRO, Australia	

* attended by video conference